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DYNAMIC RETINOSCOPY*

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One of the greatest contributions to the science and art of refraction made by optometrists has been in the development of dynamic retinoscopy. Static retinoscopy was discovered and developed by our medical colleagues and was taken up by optometrists many years later. The tables seem to be turned in the case of dynamic retinoscopy. This method was discovered and has been elaborated by optometrists from A. Jay Cross down and is just now making some headway amongst the medical refractionists.

The trials and tribulations of dynamic retinoscopy during and since Cross' day have been many and varied. Hailed by Arrington with the statement that dynamic retinoscopy professionalizes optometry, it was attacked by others with equal vigor because of its apparent unsoundness. And dynamic retinoscopy strictly speaking in its early presentation did appear scientifically unsound. The writer was among the early severe critics of the theory and an article some fifteen years ago provoked a general discussion of the method in which the best international minds in optometry took part. Notable contributions were made at the time by Lionel Laurance, who even expressed the fear that dynamic retinoscopy may threaten the very existence of optometry.

Cross with all his vast experience, knowledge and clear mind could not effectively clear away the apparent fallacies of the method. Big-minded as he was he accepted sound criticism gracefully and merely said that the theory is sound and the practice is workable despite apparent fallacies. He claimed that it was up to the younger men to search and search until they found the cause of the confusion. He felt that this confusion would be ultimately cleared up and that dynamic retinoscopy would develop beyond his original work.

It has been a frequent occurrence within the past several years to see articles on dynamic retinoscopy in which the original theories of

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Cross have been entirely discarded. New theories have been presented, sometimes on the basis of clinical experience, sometimes on the basis of theoretical deductions and sometimes on mere suppositions. The relative merits of some of these theories may be gleaned from the fact that one writer in criticizing the theory of another says the latter's reasoning is about as sound as the logic involved in the statement that because 6 and 4 make 10, 6 minus 4 also make 10.

The writer heeded Cross' advice to search for the cause of the apparent fallacies and establish the soundness of dynamic retinoscopy. That he was successful in this work may be judged from the following citations from Atkinson & Woll's recent book on Dynamic Skiametry. On page 66 the authors write: To. Dr. Joseph Pascal of New York must be given the credit for perceiving and pointing out this dual method and significance of the test." On page 67 the authors write, "It would seem, therefore, that the whole confusion which has attended the performance and interpretation of dynamic skiametry since Cross' day must be laid to the confusion between purpose and method, which it remained for Pascal to clear up."

Many have criticized Cross' theory and technique because they claimed that Cross by his method of ciliary relaxation measured primarily negative relative accommodation. In other words the additional plus lens found represented not latent hyperopia, ciliary spasm, *inefficient* accommodation, *insufficient* accommodation, etc., but primarily negative relative accommodation. Laurance, Sheard, Atkinson & Woll have especially stressed this point in one way or another. But while it is true that in some cases Cross' findings may have included some relaxation due to the negative relative range the fundamental soundness of his premises are not shaken thereby. Cross himself realized the play of other factors in the test and distinctly warns against prescribing from the findings of any one test. There is a gap between "findings" and fitting he said and several methods should be used from the *findings* of which should come the ultimate *fitting*.

In dynamic retinoscopy one must keep in mind the fundamental difference between *forcing* accommodative relaxation and permitting free accommodative relaxation. It is this latter kind of relaxation that Cross had in mind. Negative relative accommodation represents primarily the extent of accommodative relaxation with a fixed convergence when the accommodation is forced to relax in the interests of maintaining single binocular vision. Cross' method of working, at least the purpose behind the method, was not to force accommodative relaxation, but merely to allow accommodative relaxation when there is a tendency for such relaxation to take place. It is in appreciation of this fundamental difference that has caused so much confusion and given rise to apparent fallacies in Cross' method as so aptly expressed in the previous quotations from Atkinson & Woll's book.

The matter of the locking point of Cross has also been a target of criticism. Now the term is brief and expressive though perhaps unfortunate as it suggests to many a sort of rigidity, a veritable lock. But Cross certainly did not mean it in this rigid sense. That there is a sort of locking point cannot be questioned if one goes a bit into the physiology of it. The accommodation and convergence are certainly interrelated functions irrespective of which is captain and which is mate. When two activities are thus interrelated there is certainly in their associated work a certain amount of activity of one, no more no less, that best fits a corresponding amount of activity in the other. When these two activities thus exert their "best" amounts of work, we can say they are in physiological balance. It is this stage of physiological balance that Cross termed the "locking point." When the accommodation and convergence are in this state of balance they work comfortably. Otherwise they work uncomfortably. The very discomfort experienced is an expression of this urge for equilibrium. This conception is in line with the modern theory of complacency in psychology.

It is true that the accommodation and convergence can be dislodged from this state of balance, but when so dislodged there is always a tendency for them to get back to this stage of balance. Furthermore, once they reach this balanced state they will not *easily* let go. They can be *forced* to let go, but they have a tendency to stick. In this sense this state of balance may be regarded as a "locking point."

The writer realizes the contributions made to dynamic retinoscopy by such men as Southall, Treleaven, Sheard, Atkinson & Woll, Petry, Bestor, Tait, McFadden and others. Dynamic retinoscopy could not stand still; it had to develop and in the course of its development modifications of technique and a variety of new applications were introduced. But this development in so far as it is itself sound is perfectly compatible with the fundamental soundness of Cross' basic premise.

Were Cross' theories really unsound it would have been futile to try and bolster them up from a feeling of hero-worship. And unquestionably all those who knew this grand old man in optometry loved him and cherished some of that hero-worship feeling. But unfortunately Cross' basic premise when rightly understood is absolutely sound in theory and workable in practice. The edifice of dynamic retinoscopy whatever later modifications, extensions, elaborations and ornamentation may be added on rests primarily on the soundness of Cross' original premises.

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APPLICATION OF TELESCOPIC SPECTACLES TO REFRACTION*

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Introduction

The subject of Telescopic Spectacles has certainly not been receiving adequate attention from refractionists. This is probably due, first, to the general lack of knowledge concerning their optical principles, and secondly, to the fact that so very few trial sets of these telescopic spectacles are in use.

In those few articles in the American literature relating to these telescopic spectacles, the only references we find are reports on those cases where they have been prescribed. The fact that they have been successfully adopted to aid those unfortunates whose vision is too poor for ordinary lens corrections, should stimulate others to undertake more of this type of work.

Except as is pointed out further in the article, no one in the existing literature seems to have suggested utilizing certain properties of these telescopic spectacles for refraction.

To the writer's knowledge, Dr. Mark Endore of New York City, who has successfully prescribed a number of these telescopic spectacles, first observed the phenomenon referred to later in the beginning of Part 3. Professor Trealeven also observed this phenomenon independently in working with the Zeiss Subjectic Disc.

While attempting to investigate this phenomenon, the writer observed several other phenomena, some of which form the basis of this paper.

We believe that further investigations along the lines indicated in this paper will lead to a more general knowledge and use of these telescopic spectacles.

For a general elementary discussion of these telescopic spectacles, we refer the reader to Henker's "Introduction to the Theory of Spectacles."

In describing the various optical systems, we have used the notations as laid down by Professor James P. C. Southall in his various writings.

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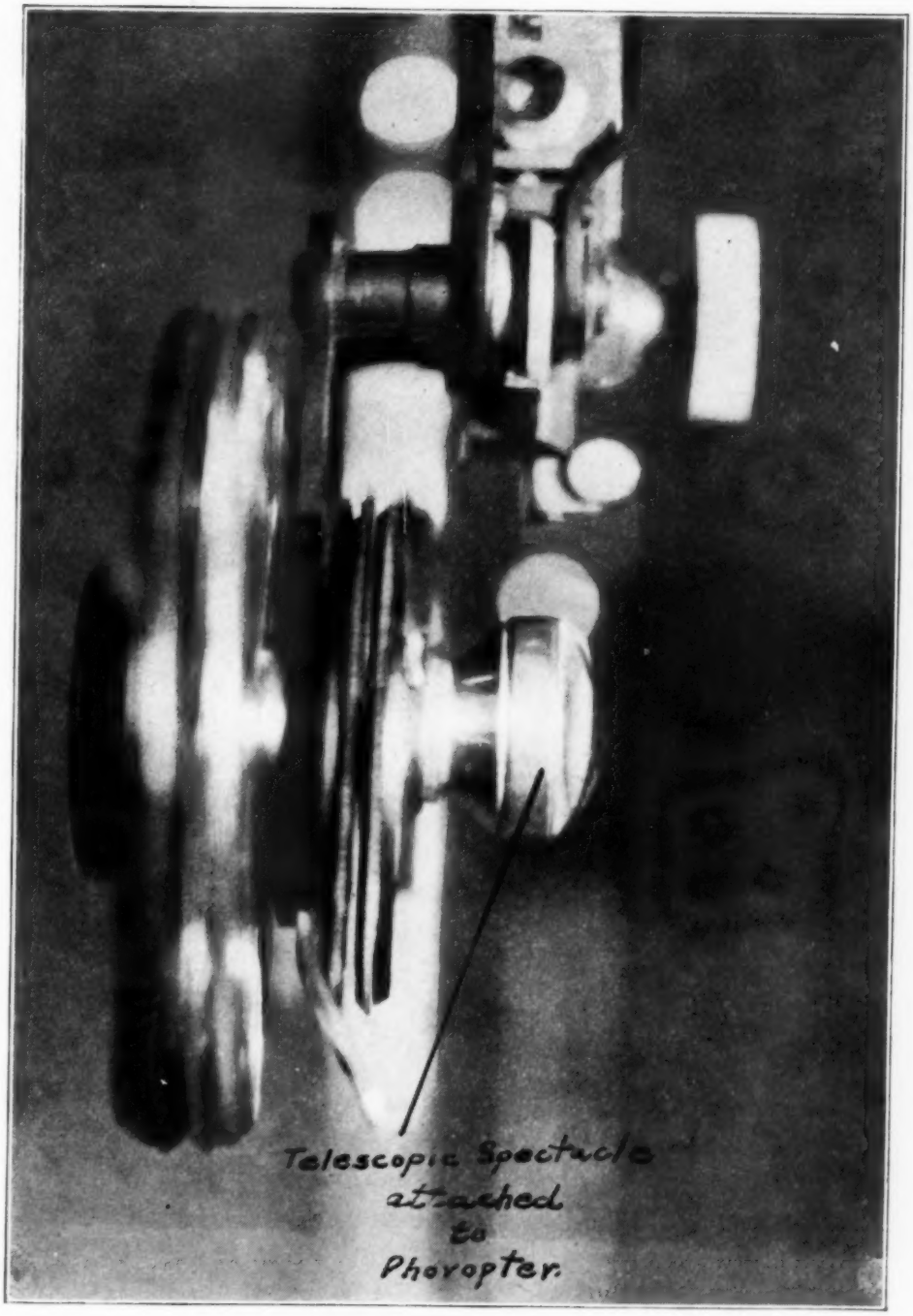
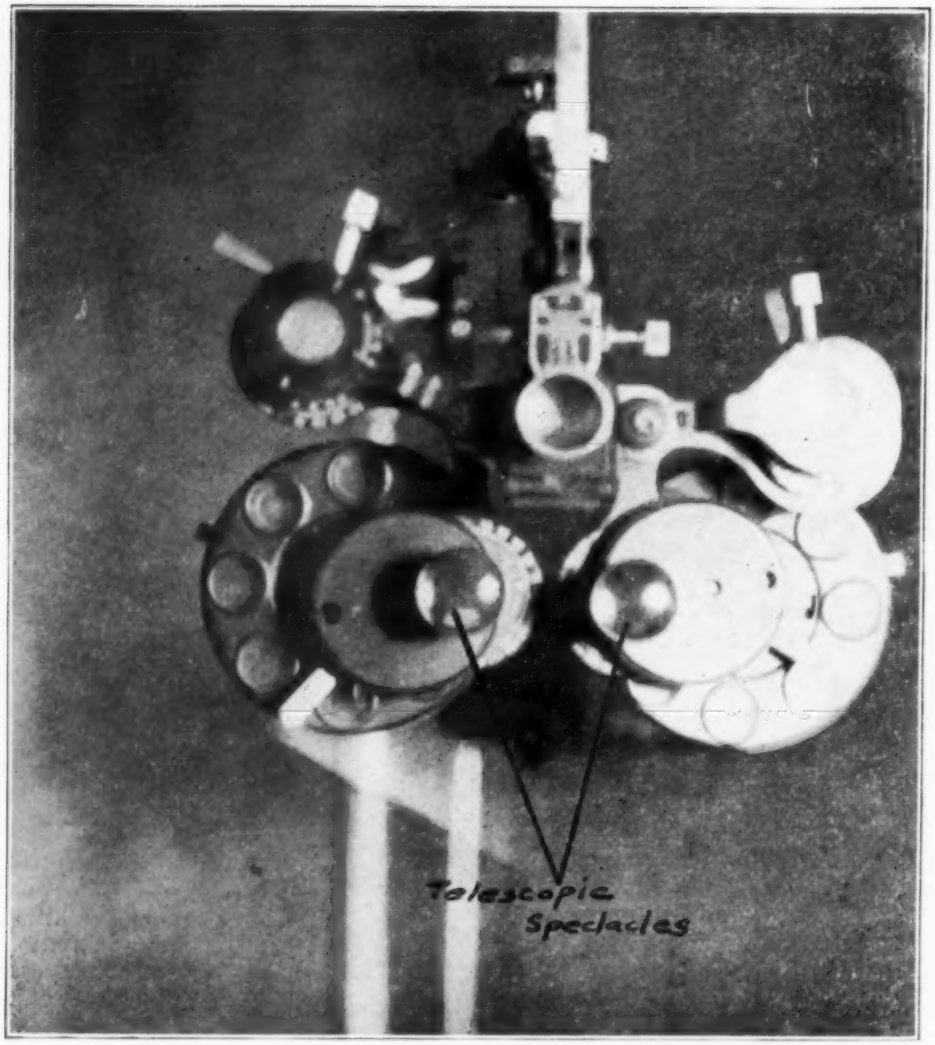
*An abridgement of material presented before the American Academy of Optometry at Boston, Mass., Dec. 16, 1929.



W. Feinbloom. Plate I.



W. Feinbloom. Plate II.

Scope of Investigations

Part 1. The Optical System of the Telescopic Spectacles.

Part 2. A Technique for Prescribing Telescopic Spectacles without the Use of a Trial Case of Telescopic Spectacles.

Part 3. Application of Telescopic Spectacles to a Subjective Examination.

Part 4. Application of Telescopic Spectacles to an Objective Examination.

Part One

The Optical System of the Telescopic Spectacles

A telescopic spectacle is of the usual Gallilean type of objective and ocular. These are so arranged, that an infinitely distant object is imaged in the focal plane of the objective, which image in turn serves as a virtual object for the ocular. Since the primary focal plane of the negative ocular coincides with the secondary focal plane of the positive objective, the resulting image will also be infinitely distant placed, but magnified. It follows, then, that with a telescopic spectacle of the type considered here (i. e., a plano telescopic spectacle), there will exist a parallel bundle of emerging rays for each parallel bundle of incident rays. (Fig. 1.)

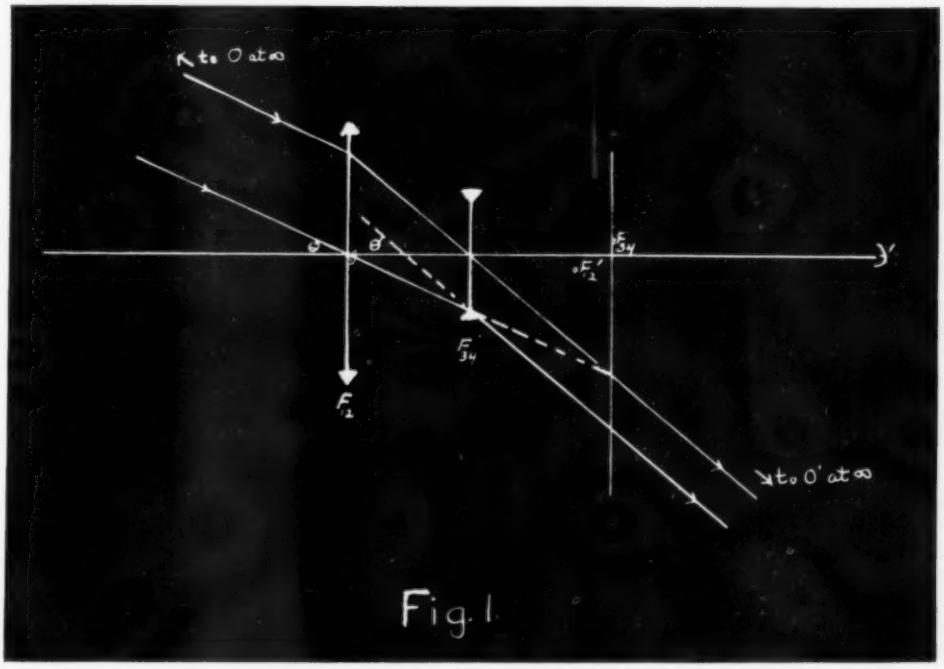


Fig. 1

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In the telescopic spectacles* with which we are concerned, the magnification or magnifying power is given as 1.8×.

Since our investigations in Part 3 and Part 4 embodied the use of these telescopic spectacles in combination with either the human eye, or other spectacle systems, it was necessary to determine the

*These Telescopic Spectacles are products of Carl Zeiss, Inc., of Jena, Germany.

optical constants of the telescopic spectacle system. This latter was done experimentally, and only with sufficient precision as was deemed necessary by the nature of the problem.

The following represents an outline of the method of arriving at these optical constants.

The makers of these telescopic spectacles supply the following data:

(1) The system is telescopic.
(2) The magnification is 1.8×.

By taking the system apart, i. e., out of the casing, the following data is obtained (Fig. 2):

(3) $F_1 = +24.75$ D.
(4) $F^2 = -0.75$ D. } Lens
(5) $F^3 = -12.00$ D. } Gauge
(6) $F^4 = -18.50$ D. } Readings
(7) $n_1 = 1.52$
(8) $n_2 = ?$
(9) $d_1 = .00570$ Meters
(10) $d_2 = .00275$ Meters

From the given and experimentally determined data, it is possible with the aid of simple formulae for thick lens systems to determine the refracting power of the objective, the ocular, their respective principal planes and the optical distance "c" between the objective and ocular.

The refracting power of the objective, $F_{12} = +24.11$ D., for

$$F_{12} = F_1 + F_2 - cF_1F_2$$

$$= 24.75 - 0.75 - \frac{.0057}{1.52}(-0.75)(24.75)$$

$$= +24.11 \text{ D.}$$

*The refracting power of the ocular,** $F_{34} = -43.40$ D. for, by definition of the magnifying power of a telescope, $M = -f_1/f_2$ where f_1 = focal length of objective, and f_2 = focal length of ocular, hence:

$$M = 1.8 = -\frac{f_{12}}{f_{34}} = -\frac{F_{34}}{F_{12}} = -\frac{F_{34}}{24.11}$$

or $F_{34} = -43.40$ D.

Value of "c" = 1.8 cm., for

$$F = F_{12} + F_{34} - cF_{12}F_{34}$$
$$O = 24.11 - 43.4 - \text{"c"}(24.11)(-43.4)$$

or "c" = 1.84 cm.

*The ocular in the Telescopic Spectacles is really an achromatic doublet, but for the purposes of calculations, we may substitute a single lens of the above equivalent refracting power and assigning it an index of $N_2 = 1.73$ as is shown further. The possible error resulting from this simplication does not affect the final results as is shown by the Graph in Part 3.

The position of the principal planes in the objective are
$A_1 H_1 = .0001$ meters and $A_2 H_1 = -.0039$ meters, for (Fig. 2).

$$A_1 H_1 = \frac{F_2}{F_{12}} C_1 = \frac{-0.75}{24.11} \frac{.0057}{1.52} = -.0001 \text{ meters}$$

$$A_2 H_1^1 = -\frac{F_1}{F_{12}} C_1 = -\frac{24.75}{24.11} \frac{.0057}{1.52} = -.0039 \text{ meters}$$

and $H_1 H_1^1 = H_1 A_1 + A_1 A_2 + A^2 H_1^1$
$= .0001 + .0057 - .0039$
$= .0019$ meters $= 1.9$ mm.

The position of the principal planes in the ocular are
$A_3 H_2 = .0009$ meters and $A_4 H_2^1 = -.0006$ meters, for (Fig. 2) from previous data—

$d_2 = .00275$ meters
$F_{34} = -43.40$ D.
$F_3 = -12.00$ D. } gauge calibrated for $n = 1.52$
$F_4 = -18.50$ D. }

$$\text{Hence } F_3 = -12.00 = \frac{1.52-1}{2_3}, \div V_3 = -.0433 \text{ meters}$$

$$F_4 = -18.50 = \frac{-1.52+1}{2_4}, \div V_4 = .0281 \text{ meters}$$

and since,

$$F_{34} = F_3 + F_4 - cF_3 F_4$$

$$-43.4 = \frac{1-N_2}{.0433} - \frac{N^2-1}{.0281} - \frac{.0028}{N_2} \left\{ \frac{(1-N_2)}{.0433} \times \frac{-(N^2-1)}{.0281} \right\}$$

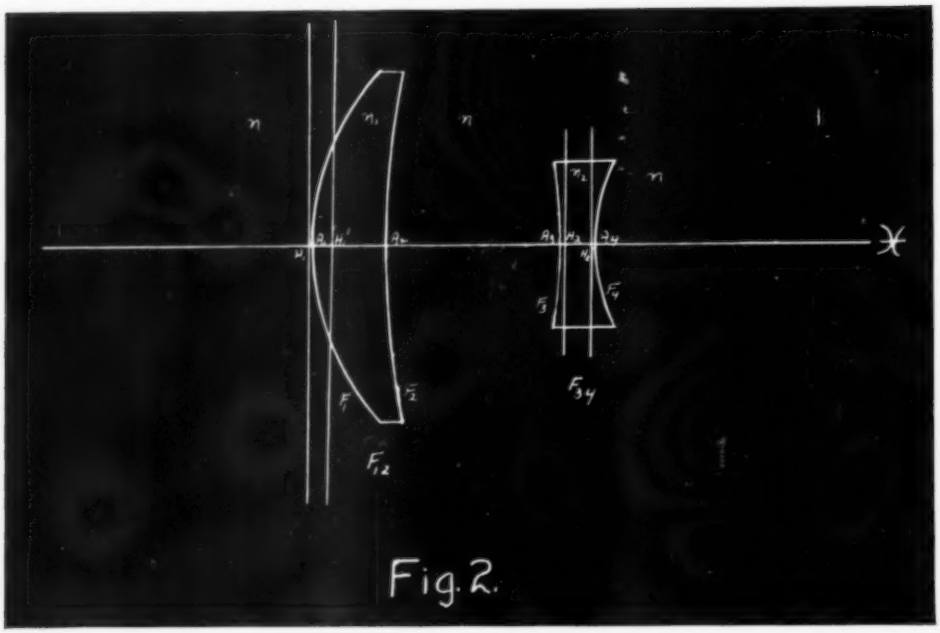
or $N_2 = 1.73$,

and therefore $F_3 = \frac{1.73-1}{-.0433} = -16.9$ D.

$$F_4 = \frac{-1.73+1}{.0281} = -25.9 \text{ D.}$$

Hence,

$$A_3 H_2 = \frac{F_4}{F_{34}} C = \frac{-25.9}{-43.4} .0015 = .0009 \text{ meters}$$



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$$A_4\ H_2^1 = -\frac{F_3}{F_{34}}\ C = -\frac{-16.9}{-43.4}\ .0015 = .0006 \text{ meters}$$

Part 2.

A Technique for Prescribing Telescopic Spectacles without the Use of a Trial Case of Telescopic Spectacles.

The usual method of examining a pair of eyes for the purpose of prescribing telescopic spectacles is to determine that lens correction, with ordinary spectacles, which gives maximum acuity, and then to make up that correction in telescopic spectacle form and again measure the acuity. Where, as is usually the case, more than one combination of ordinary lenses gives the same maximum acuity, it is necessary to make up these several telescopic spectacle combinations, and then, by trial and error, determine that combination which gives maximum acuity.

Those who have had experience with the above, fully appreciate the difficulty on the part of the patient in judging one telescopic spectacle combination against another, due to the time interval necessary to change from one to another. Since, by far, most practitioners have no telescopic spectacle trial case, they entirely forego the above procedure even in many cases where the need of telescopic spectacles is directly indicated.

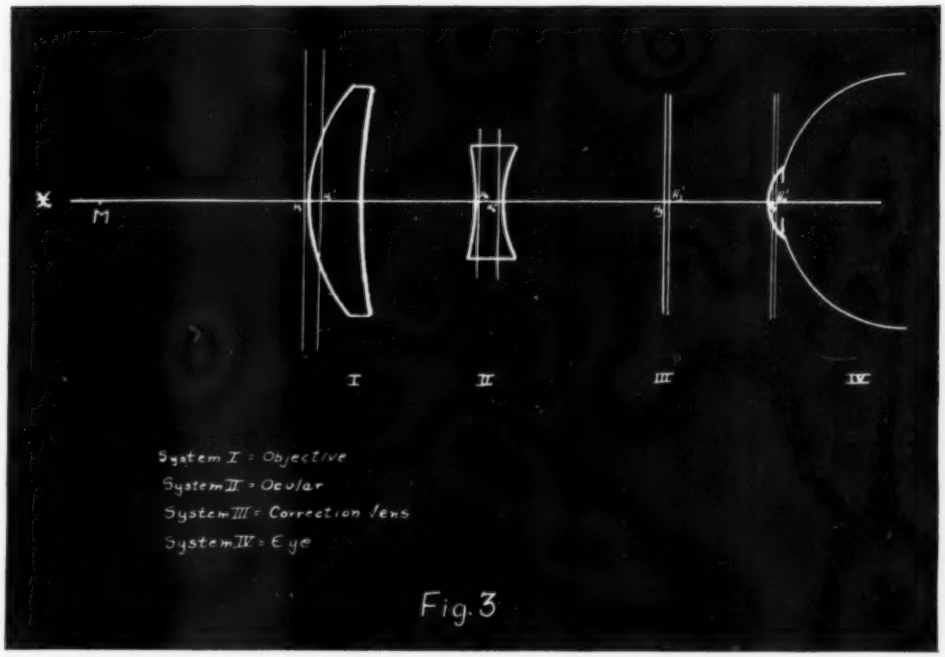

Fig. 3

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From the optics of the telescopic spectacle it is apparent that when a plano telescopic spectacle is placed before an emmetropic eye, the effect of this telescopic spectacle is to increase the size of the retinal image 1.8× and hence also the visual acuity 1.8×. It follows, then, that if we can make the examined ametropic eye, emmetropic, with ordinary lenses and then insert a plano telescopic spectacle before the entire combination, i. e., eye and ametropic correction, we would achieve the same optical effect as if we had taken a telescopic spectacle of the ametropic power and placed it before this eye.

It is advisable to recall here the fact that not all emmetropic eyes have normal acuity. All cases requiring telescopic spectacles will have subnormal acuity even when made optically emmetropic by the usual ordinary lens correction.

To enable one to prescribe telescopic spectacles without the use of a trial case of telescopic spectacles, the following technique was evolved:

Step 1. Mount a single plano telescopic spectacle of magnification 1.8× in a metal disc as in Fig. A. The diameter a = size of lens holder in either phoropter, refractor or trial frame. (Hereafter when referring to telescopic spectacle, we shall mean this telescopic spectacle as mounted in the disc. See photograph.) "B"=diameter of eye piece in telescopic spectacle.

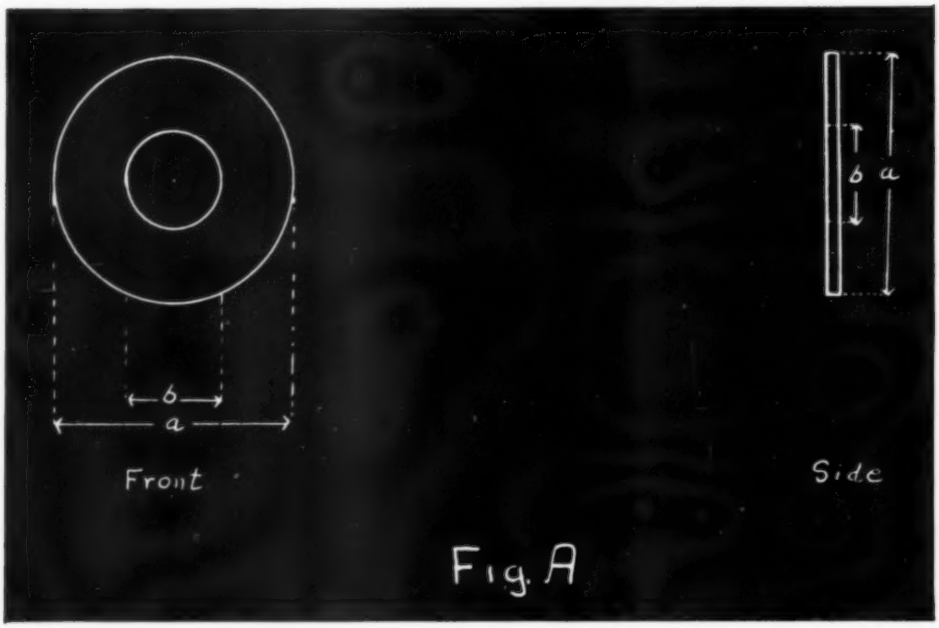

Fig. A

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Step 2. Arrive at some satisfactory subjective finding as usual. Record the visual acuity with this ordinary lens correction. Then insert the telescopic spectacle before this finding, i. e., in the phoropter, refractor or trial frame.

Step 3. Using the smallest test type now visible, and we believe the Classon Visual Acuity Meter serves most excellently here, make small lens changes in the usual way, without in any way moving the telescopic spectacle. Record the acuity with the telescopic spectacle correction. This latter acuity should be approximately 1.8× as great as that recorded in Step 2. If it differs materially from this figure, a valuable diagnostic conclusion can be drawn as will be indicated later.

Step 4. The prescription as found with the telescopic spectacles must be prescribed in full for distance correction. This is essential, for this correction is such as to make the fovea as nearly conjugate to the far point as is possible, even though normal acuity does not result. Should the Rx be undercorrected, then the blurred circles on the retina would be correspondingly magnified 1.8× with a consequent decrease in acuity.

Step 5. For any near point correction, place the reading card at the desired distance, and rotate behind the telescopic spectacle that additional plus lens that gives maximum vision. If the resulting vision is not sufficient, e. g., to read ordinary newspaper type, then move the test object, i. e., the card, closer and increase the plus until best vision results. The resulting reading addition is not the lens to prescribe, for in ordering telescopic spectacles, the reading additions are placed as *front* lens attachments. However, the proper front lens attachment can easily be determined by converting the object distance, i. e., the distance of the card to the telescopic spectacle into diopters. Thus, if the card is at 40 centimeters and the resulting visual acuity is sufficient then the front lens attachment is +2.50 D. S., and similarly if we must approach to 20 centimeters, then the necessary front lens attachment is +5.00 D.

Drs. H. S. Gradle and J. C. Stein* present another way of arriving at a front lens attachment that is theoretically correct. We have found, however, that by the above method the required near addition will sometimes be less.

Part 3.

The Application of Telescopic Spectacles to a Subjective Examination.

It is a common experience among refractionists that in the examination of amblyopic cases, difficulty is encountered in subjectively selecting that particular correction that gives maximum acuity. We are here referring to those cases where the use of telescopic spectacles is not ordinarily indicated. Similarly in cases of high ametropia, either spherical or cylindrical, the patient will have difficulty in selecting one particular combination of lenses, for he may have equal acuity with corrections that vary by one to three diopters from each other.

It is in such cases that the use of the telescopic spectacles in combination is of assistance. With the telescopic spectacles in place, the usual subjective test is made (monocularly). The acuity will usually be increased 1.8× and with the patient observing the smallest letters now visible, various changes in the correction are tried. In most cases, the patient will select with much more certainty a particular correction, against a previous existing uncertainty. This phenomena has been sufficiently demonstrated to warrant the above statement.

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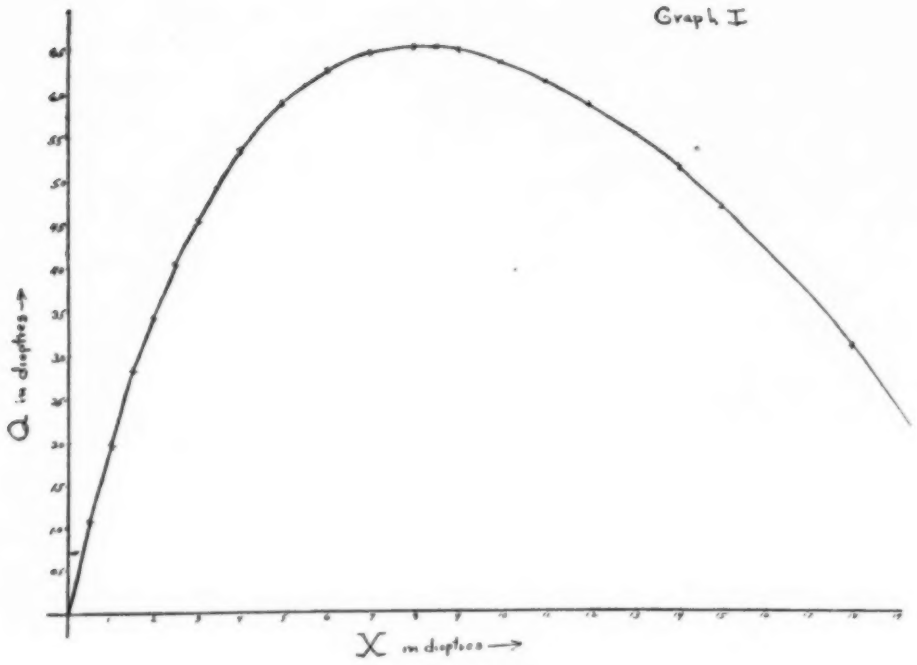
*Drs. H. S. Gradle and J. C. Stein "Telescopic Spectacles and Magnifiers as Aids to Poor Vision," Transactions of Section on Ophthalmology of the American Medical Association, 1924.



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Thus far, we have not been able to fully explain this phenomenon. In some way, the ratio of the size of the blurred circles to the size of the retinal image, with any given lens correction, is different when the telescopic spectacles attachment is interposed.

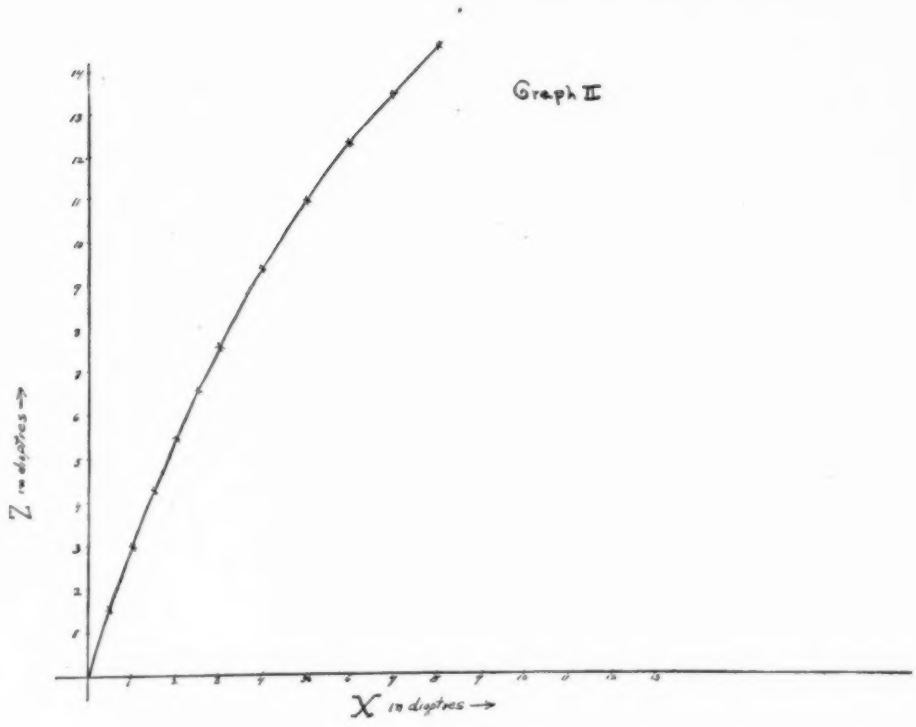
We have also encountered cases where the use of this telescopic spectacle combination resulted in an increase of either less than 1.8× or more than 1.8×. We have recorded several cases where the telescopic spectacle combination made no improvement at all in the vision. Drs. Gradle and Stein in their treatise also report this phenomenon, and we believe the explanation they offer to be correct.

Their explanation is that in cases where the acuity is increased more than 1.8× then we are dealing with a disease process involving the macula alone. The resulting magnified image falls upon that para central retinal area that is not diseased. In these cases, we carefully plot the fields tangemetrically and have thus far (in three cases) outlined definite absolute scotoma.

We wish to cite a particular instance of the above.

Case Mr. H. O.

Date	V. A.	R%	L%
	Naked Vision	15	37
5-11-29	with Rx: R—75 D. S.		
	L.—25 D. S. —25×180	60	60
	with Rx and Telescopic Spectacles	70	70



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5-18-29	with same Rx	65	140
	with same Rx. + Telescopic Spectacles	145	60
5-25-29	with same Rx	85	80
	with same Rx + Telescopic Spectacles	over 150	over 150

This case presented a complicated history of three attacks of retrobulbar neuritis, the last one occurring two months previous to the first examination. Evidently the immediate area surrounding the fovea was affected on May 11, 1929, and the resulting increase in the size of the retinal image brought no increase in acuity. The increase in acuity with the telescopic spectacles on May 18, 1929, showed the condition to be improving for the improved acuity without the telescopic spectacles was negligible. This particular case was plotted tangemetrically on each occasion and showed definite improvement as far as existing scotoma around the macula.

We have tried to use this phenomenon in an attempt to differentiate those cases of amblyopia that may really be ex-anopsia from those cases where the amblyopia is not ex-anopsia. If the telescopic spectacle improves the vision at least 1.8×, then we are beginning to believe the visual acuity can be improved through training. If, however, the telescopic spectacle does not bring about such an

improvement or actually produces poor visual acuity, then we are beginning to believe that no improvement can be produced. To date, we have only had two cases where the visual acuity was not improved by the telescopic spectacle, that we have undertaken to develop. In both of these, we used all of the usual methods of stimulation and occlusion without avail. The patients were seen three times a week for an hour each time. Two hours of daily work at home were required consisting primarily of transcribing. This treatment extended over a period of one month. It is possible, of course, that over a much longer period better results would have been obtained, but, it was deemed advisable to carry the work no further. In reference to other types of amblyopia, we feel that the possible degree of development is in some way related to the increased visual acuity resulting from the use of the telescopic spectacles combination.

Part 4.

The Application of Telescopic Spectacles to an Objective Examination.

From the optics of the telescopic spectacles, it must be apparent that the normal accommodative power of a young person would be insufficient to enable this individual to read ordinary small type through these telescopic spectacles. Starting with this fact, we thought it might be possible to utilize it as the basis for a new technique in skiametry, a technique that would perhaps tend to hold the accommodation in check more definitely than our present ones.

Although we have as yet by no means perfected such a technique, we have during the course of our experiments observed two interesting and useful phenomena.

With the telescopic spectacle combination in place in the phoropter before one eye, with the other eye fixing a distant target, the retinoscope is used as ordinarily in a static skiametric test. One immediately notes that the size of the pupillary opening or the reflex is about twice the normal size. The effect of the telescopic spectacles is to magnify the pupil. This has been especially useful in refracting patients with very small pupils upon whom it was otherwise quite impossible to conduct a skiametric test.

The second phenomenon observed was that in those cases of skiametry, where the reflex was distorted by peculiar scissor movements or striations, or secondary areas, the addition of the telescopic spectacle combination seemed to eradicate them and present a more clear and definite reflex for observation and neutralization.

In using the telescopic spectacle combination for a retinoscopic test, certain deductions from the lens value giving neutralization will be required in order to arrive at the true static error or ametropia. These deductions are necessary because the combined system of

telescopic spectacle and eye are quite different from the eye itself.

The necessary deductions or allowance, which is primarily a function of the working distance may be arrived at as follows: In Fig. 3 let

(1) X = Dioptric vergence of H_1M.

(2) Y = Dioptric vergence of emerging rays from H_2^1.

(3) $c = H_1^1 H_2$.

(4) $a = H_2^1 H_3$ = distance between ocular and correction lens in phoropter = 2 cm.

(5) Z = Dioptric vergence of rays incident upon H_3.

(6) $-Q$ = Lens addition required.

From the figure, it is evident that with the patient fixing a distant object and the examiner working at the point M, that neutrality will be obtained at this point when M is conjugate to the retina of the patient. When this condition is obtained without the use of the telescopic spectacle combination, and then the telescopic spectacle combination is interposed, the condition will no longer hold; hence that lens which will restore that condition of conjugacy will be $-Q$.

Therefore:

(1) $X + F_1$ = Dioptric vergence of emerging rays from F_1 (where X is negative).

(2) $\dfrac{100}{X + F_1}$ = Distance between focus of rays emerging from F_1 and lens F_1.

(3) $\dfrac{100}{\times + F_1} - c$ = Distance between F_2 and previous point of focus.

(4) $\dfrac{100}{\dfrac{100}{X + F_1} - c}$ = Dioptric vergence of rays incident on F_2.

(5) $Y = \dfrac{100}{\dfrac{100}{X + F_1} - c} + F_2$ = Dioptric vergence of emerging rays from F_2.

(6) $= \dfrac{100\ (X + F_1)}{100 - c\ (X + F_1)} + F_2$

and by analogous method

(7) $Z = \dfrac{}{\dfrac{100}{Y} + a}$ (where a and Y are always of the same sign)

$$= \frac{100Y}{100 - 2Y}$$ (where a = — 2, for Y is negative)

(8) or

$$Y = \frac{100\ (X + 24.11)}{100 - 1.84\ (X + 24.11)} - 43.4$$

$$Z = \frac{100Y}{100 - 2Y}$$

$$Q = Z - X$$

TABLE OF VALUES FOR Q AND Z WITH GIVEN VALUES OF X

X	Q	Z
0	0	0
0.50	1.10	1.60
1.00	2.00	3.00
1.50	2.79	4.29
2.00	3.46	5.46
2.50	4.04	6.54
3.00	4.54	7.54
4.00	5.33	9.33
5.00	5.89	10.89
6.00	6.26	12.26
7.00	6.47	13.47
8.00	6.54	14.54
8.50	6.53	15.03
9.00	6.50	15.50
10.00	6.37	16.37
11.00	6.16	17.16
12.00	5.87	17.87
13.00	5.53	18.53
14.00	5.12	19.12
15.00	4.70	19.70
18.00	3.11	21.11
20.00	1.89	21.89
24.00	— 0.8	23.20

Z is evidently, that dioptric value that must be algebraically added to those findings that give neutralization for a given value of X, in order to arrive at the true static ametropia, i. e., $A^1 + Z = A$ where A^1 = neutralizing lens value in phoropter A = true ametropia.

Notes

In conducting a skiametric test with the telescopic spectacle in place, it is necessary for the observer to remain absolutely fixed at the same point of observation throughout the test. A small change in his position of observation will produce a fairly large change in the neutralizing lens as is seen from Graph 2. It is also important that the distance X be measured from the front surface of the objective of the telescopic spectacle (approximately the position of the first principal plane) and not from the eye itself.

Graph 2 gives the relation between Z and X. Thus, for any given distance at which the skiametric test is made (i. e. X), we find a definite value of Z which must be algebraically added to that combination of lenses that neutralizes the reflex at this working distance. From the nature of the problem, Z is always negative and hence must be algebraically added.

Conclusion

Telescopic spectacle attachments may be used in refraction:

1. During the skiametric examination, when,
   (a) The pupils are otherwise too small for skiametric work.
   (b) The observed reflex is distorted, due to abberations.
2. During a subjective examination, when,
   (a) The patient's Fechner fraction for form perception is high.
   (b) The existing amblyopia is to be prognosticated.
3. To prescribe telescopic spectacles for both distant and near use.

The above work was carried out with the co-operation of my associate, Dr. M. A. Silverman. We are indebted to Dr. Samuel Goldman for his assistance in the various parts of the work.

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NEW YORK, N. Y.

SOME THOUGHTS ON GEOMETRICAL OPTICS*

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The four previous drawings and demonstrations require, for a thorough understanding, a clear and precise and definite knowledge of Refraction as applied to Single Curved Surfaces, Lenses, of all forms, and of Series of Lenses, both in the same and in different media.

As knowledge of the S. C. S. (single curved surface) forms the basis of all subsequent calculations in Optics, this should be first considered.

DRAWING V.

Drawing V shows a S. C. S. on a block of crown glass: a light point on its Pr. Axis: and a Diaphragm near the surface permitting the passage of a pencil of Rays.

If the Diaphragm be so placed that the central axial Ray of the pencil shall pass through the C. of C. (center of curvature) then it is obvious that it will pass along a Pr. Ax. of the curve, will follow also a Radius of the Arc, and hence be perpendicular to the surface: and also that the limiting Rays of the pencil being equally distant from the axial ray, will suffer a like refraction and will meet at a common point on the Pr. Ax. By the Arc and Sine method of Refraction (or the Single Perpendicular method) this Image point may be found graphically (by drawing only). But as it can be found more surely and exactly by calculation, the latter method will be here followed.

Let the Obj. point be designated as CF′ (Conjugate Focus one) and the Image point as CF.″

In order that our drawing may be confined within the limits of the page, we have chosen a Radius of 1″. This divided by our Excess

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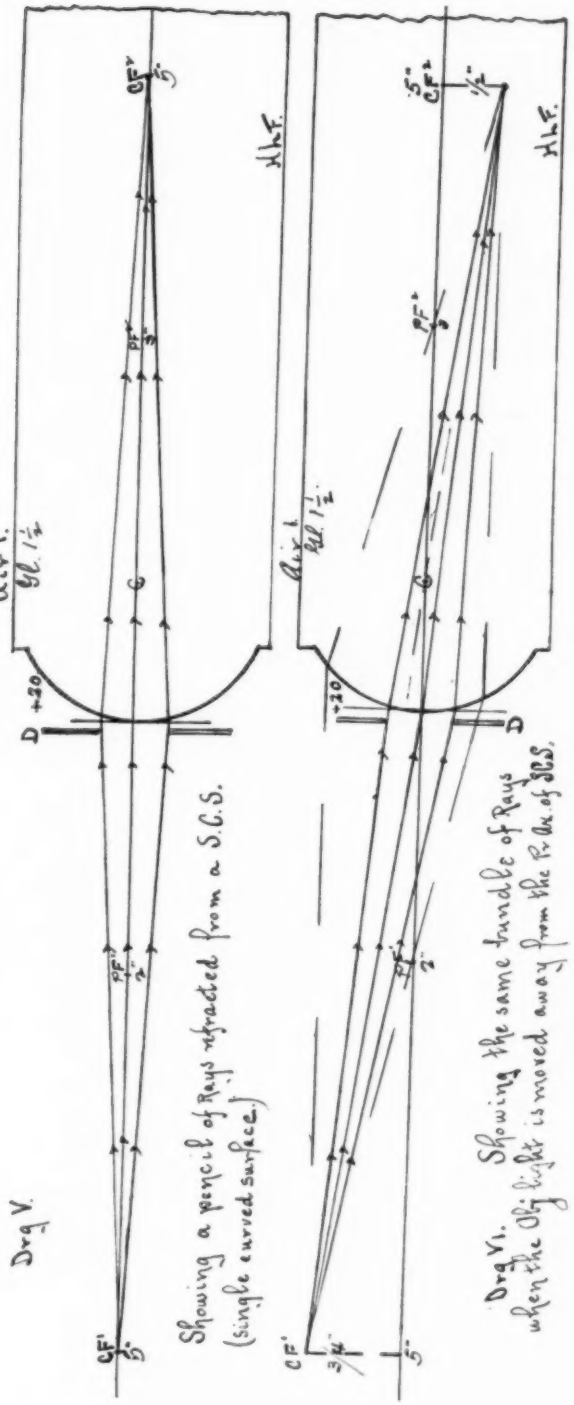


Dra V. Showing a pencil of Rays refracted from a S.C.S. (Single curved surface.)

Dra VI. Showing the same bundle of Rays when the Obj. light is moved away from the Fr. Ax. of SCS.

Index ½ gives a PF′ of 2″ and a power of +20D. CF′, 5″ = —8D: + 20.D = + 12.D (air) which divided by the Index gives +8D (gl.), which gives a focus of 5″ in the glass.[1]

DRAWING VI.

In Drawing VI the light point has been moved ¾″ from its position in Drawing V. The Diaphragm has been left in the same position, almost against the glass, so that the pencil of Rays still strikes the same surface, with its axial ray crossing the Pr. Ax. at its intersection with the arc. The Image point will then be moved to a point on the opposite side of the Pr. Ax. and ½″ from its position in Drawing V. For the axial ray of the pencil now follows the Law of Refraction, at the surface, so that the angles at N formed by the Ray and the Pr. Ax. (here the perpendicular) are inverse to the Indices of 1½/1 or 3/2. Hence the distance of CF′ and CF″ from the Pr. Ax., (representing sines of a circle whose center is at N) hold the ratio of 3/2. And CF′ being ¾″, CF″ must be ½″ from Pr. Ax. So that the Image point may be definitely calculated and located without any reference to the point C (the center of Curvature).

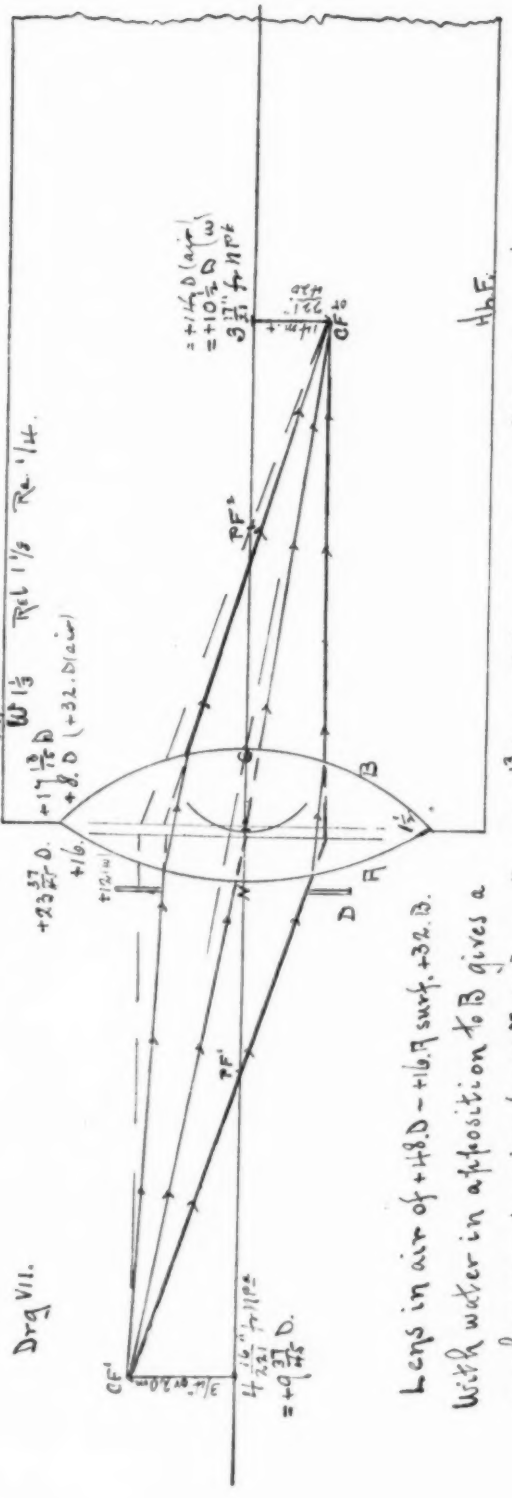
For this is obvious, that when the Obj. and Im. (or CF′ and CF″) lie at the same distance from the surface the distance of CF″ from the Pr. Ax. (or the Im. height) will equal the CF′ distance (or the Obj. height) divided by the Index of the glass. And it is equally obvious that if CF″ is twice CF′ distance from the surface, then it will be

$$2 \times \frac{\text{CF′ height}}{\text{Index}}$$

And whatever the distances of CF′ and CF″ from the arc and from the Pr. Ax. the Im. height (or distance of CF″ from Pr. Ax.), will always equal the distance of CF′ from the Pr. Ax. divided by the Ind. of denser medium, and this multiplied by the Im. distance from the surface divided by the Obj. distance from the surface: or to express it briefly

---

[1]NOTE: The term Excess Index (Ex. Ind.) is used instead of the expression n — 1, because it is the expression of a definite entity. The difference in Index between the two media is always an expression of the refractive power of a plane surface between them. Or to state it another way, it represents the increase of the angle in the rarer medium over that in the denser medium, when measured on their respective sines. Hence it is just as definite an entity as is the term Index. If so, then to speak of it always as the difference of two quantities, is analogous to saying one dollar less twenty-five cents when we speak of seventy-five cents; or of an article worth 50 cents, to say it is worth $1.50 less $1.00. The author of this article did not originate the expression Excess Index but accepted it long ago as a most sensible expression.


Dry VII.
Lens in air of +18.D – +16.9 surf. +32.B.
With water in apposition on to B gives a
real power in air of +23 37/45 D: in water, +17 13/15 D: Focus in air of 1 41/134": in w, 2 1/69".
Showing a divergent pencil bent toward the PrFPrs, and converged at the corresponding point of Image. Showing also its equivalent single curved surface, and its location.
Note:- Central axial ray passes from A to B surfaces thro the Optical Centre: not thro Nodal Points.
Axis
W 1/3 Refr 1/8 Re 1/14.
+17 1/2 D
+8.D (+32.D/air)
+23 37/45 D.
+1/6
+1/2(w)
PF'
PF''
CF'
CF''
A
B
D
H.P.
H.P.'
= +10 1/2 D (w)
3 21/41 from H.P.''
= +0 37/45 D.

$$\frac{\text{Obj. ht.}}{\text{Ind. gl.}} \times \frac{\text{Im. d.}}{\text{Obj. d.}} = \text{Im. ht.}$$

Now all the innumerable rays composing this pencil must be refracted to the same point. One of these must strike the curved surface so that it shall follow along the line of the Radius, passing through C. Hence a straight line drawn through C. must pass to CF″ and help to form the Im. point. It has been discovered also that a line drawn parallel with the Pr. Ax. from CF′ to the arc, and then bent to CF″, will pass through PF″ of the surface. While a ray following this line dose not come from infinity, but from the finite distance of 5″, and has a convergent power of +8D after refraction, and must meet the ray passing through C at 5″, yet before reaching CF″ it follows the course of a ray coming from infinity and so passes through the PF″.

Hence CF″ may be located graphically, with some degree of accuracy, by drawing (1) the line from CF′ through C; and (2) the line parallel with the Pr. Ax. and through PF″.

And if a Ray be drawn from CF′ through PF′ it will, after refraction, be found to meet the other rays at CF″ and will lie parallel in the glass to the Pr. Ax. And because of the fact that these three rays, indicated by dotted lines, incidentally pass through the Pr. Foci and C of C, that they have been used by many authors to locate the corresponding points of Object and Image.

The word "incidentally" is used, because in so far as any deductive reasoning is employed, there is no logical reason for these facts:

(1) That in Drawing VI a straight line between CF′ and CF″ should pass through C.

(2) That a Ray from CF′ parallel with the Pr. Ax. with a divergent power of —8D, and a convergent power in the glass of +8D, should pass through PF″.

(3) That a Ray from CF′ through PF′ with a —8D power in the air and a +8D power in the glass, with a consequent focus of 5″, should lie in the glass parallel with the Pr. Ax.

For because PF″ in the glass is the focus of rays coming from infinity, which are called parallel because their divergence is inappreciable, and because a divergent ray (whether the axial or limiting ray of a pencil) from, say 5″, passes along a ray from infinity through this 5″, and finds its focus somewhere in a plane 5″ from the refracting surface, this fact does not carry with it any proof that it will pass through PF″. That it does so, is simply the chance discovery of an incidental fact. As demonstrated in Drawing VI, CF″ can be located definitely and unmistakably without any knowledge of the location of the Center of Curvature and the Pr. Foci.

This pencil of divergent rays from CF′ with its focus at CF″ was drawn without any consideration of the points PF′, PF″ and C. The dotted lines were drawn later, and it was then found that the points of their crossing the Pr. Ax. measured exactly 2″ and 3″, which are the Pr. Foci of the +20D Curve. A straight line was then drawn from CF′ to CF″, and was found to pass through the center of curvature. These points were then marked upon the drawing simply to illustrate the facts of the discussion.

Now if the diaphragm be moved up and down letting this pencil of rays strike the surface anywhere between the dotted lines its focus at CF″ will not be altered. It is obvious that refraction takes place wholly and only at the curved surface. The point C. does not alter this refraction and has no direct influence upon it, and need not be known.[1]

In finding CF″ graphically it may be used. It may also be convenient at times to use it in calculations of Image or Object height. For when the straight line is drawn from CF′ to CF″ through C. then we have two triangles with their apices at C. and with the Object and Image as their bases. Then by adding the Radius to CF′ and deducting it from CF″ we have the heights and bases of the triangles holding the ratio of 3/2.

DRAWING VII.

Now let us consider Drawing VII. The purpose of this drawing is to demonstrate the position of the Optical Center, and of the Nodal Points from which Object and Image are measured: also the position of a Single Curved Surface and that of its Center of Curvature, which may be substituted for this lens.[2]

A lens has been chosen of +48D in air: surface A +16D and B +32D with a thickness of 1″ and Index of 1.5. With water in apposition to B surface, its power is reduced to ¼ of +32D or +8D.

Now to find the OC: — this point divides the thickness into two parts having the ratio of 12.D (power of A in water) to 8.D or 3/2. And the OC always being nearer the surface of greater power, it must be 2/5″ from A and 3/5″ from B.

To find the NP's: — in all bi-convex lenses the OC is CF′ to the Nodal Points. Hence, 2/5″ = —100 D (glass) = —150 D (air), +16 D = —134 D, $= -\frac{20''}{67}$ from A to NP[a].

[1]NOTE: The effect of spherical aberration need not be considered in this discussion, for this, of course, is a vitiating influence which we have always with us.)

[2]NOTE: In this drawing the central Axial Ray should be drawn through the O. C. It is not done here lest it blot out the dotted lines.

And $3/5'' = -66\,2/3$ D (glass), $\times \frac{9}{8} = -75$ D (water), $+8$ D $= -67$ D, $= -\frac{40''}{67}$ from B to NP^b.

To find the real power of the lens in air and water, we shall first find the Pr. Foci, by refracting parallel rays from both directions.

Ray in air at A goes toward $3\frac{3}{4}''$ from A and $2\frac{3}{4}''$ from B, $= +160/11$ D (glass) $= +180/11$ D (water) $+8$ D $= +24.4/11$ D, $= 1.43/67''$ F from B, $+40/67'' = 2.16/67''$, PF″ from NP^b, $= +17.13/15$ D (water).

Ray in water at B goes toward $5\frac{5}{8}''$ from B, and $4\frac{5}{8}''$ from A, $= +\frac{320}{37}$ D (glass), and $+\frac{480}{37}$ D (air), $+16$ D $= +28.\frac{36}{37}$ D, $= 1.\frac{51''}{134}$ from A, $+\frac{20''}{67} = 1.\frac{91''}{134}$ from PF′ to NP^a, $= +23.\frac{37}{45}$ D (air).[1]

An Object is now placed at $4.\frac{16''}{221}$ from NP^a, and from its highest point CF′ a pencil of rays, after passing through a diaphragm, is refracted through the lens to its focal points CF″, which is obviously the corresponding point of the Image. As the OC of a bi-convex lens is that point on the Pr. Ax. through which every secondary ray must pass (or the axial ray of a pencil), then by placing the diaphragm so that the central or axial ray of the divergent pencil passing through it shall pass through the OC of the lens, we shall have the central axial ray of the convergent pencil passing on (if in the same medium) in the same direction but displaced laterally, due to the refraction at the surfaces. But if the second medium have a greater optical density, then the axial ray of the convergent pencil will be bent toward the Pr. Ax. and the focus, or CF″, will be a distance from the Pr. Ax., found as in Drawing VI by dividing the distance of CF′ from the Pr. Ax. by the index of the water, and then multiplying this by image distance/object distance.

If CF′, or the object height, be $\frac{3}{4}''$, then the Im. height will be $3.17/21/4.16/221 \times 3/4/4/3 = 221/420''$ or $17/32''$ app. Or if object height be called 20 mm., then image height will be approximately 14 mm. Having thus definitely located CF″, we refract our limiting rays of

[1]NOTE: That the Pr. Foci and Powers hold the ratio of 4/3 or Ind. water/Ind. air, as they must do.

the pencil. This may be done by several methods. We have here used the imaginary or hypothetical planes known as the nodal planes.

It will be observed that the pencil of light has its lower limiting ray pass thru PF′ and parallel with the Pr. Ax. in the water. The upper limiting ray, being equi-distant from the axial ray, can not possibly pass thru PF″. Now if the diaphragm be moved up so that the upper limiting ray shall follow the line of a parallel ray (the dotted line), then the lower limiting ray will pass above PF′. If the pencil be narrowed, then neither limiting ray will pass thru the Pr. Foci. If the opening in the diaphragm be enlarged so that both the upper and lower limiting rays shall pass thru the Pr. Foci, then the central axial ray of the cone would, if it could pass thru the lens without refraction, lie in a straight line from CF′ to CF″, and would pass thru the C of C of a single curved surface placed at the optical center of the lens, and having the powers of the lens.

But such a pencil cannot form a clear image. It does not constitute a secondary ray (or pencil). It is an impossible hypothesis. For no axial ray (excepting Pr. Ax.) of any pencil of light falling upon surface A, can possibly pass straight thru the lens and thru the point C. Nor can any refracted axial ray pass thru this point near the posterior lens, and focus at CF″. But if the SCS be substituted for the lens, then as illustrated in Drawing VI, the axial ray of a pencil, having its limiting rays pass thru the Pr. Foci, will fall upon the arc perpendicularly, will follow a radius, and hence will pass thru the center of curvature, and will lie in a straight line between CF′ and CF″.

Now in Drawing VII two distinct lenses may be substituted for this lens with a medium of the same index between them, without altering the foregoing calculation; or the index of the intervening medium may be altered, and reduced to that of the water, and still the nodal points will be moved very little.

Hence we must conclude that the nodal points of the eye system must lie, as shown in Drawings III and IV just back of the cornea, that from these points the Pr. Foci, and all conjugate foci are measured; that thru these points (or to be more exact, the O. C. which is almost identical) all secondary rays which help to form a clear image, must pass. But in our schematic drawings of rays passing from an object of regard to the retina, it is more convenient to use straight than refracted lines. Hence we substitute for the cornea and lens, a single curved surface placed at the optical center, and then draw our straight line thru the center of curvature, and this C of C will be located in the human eye near the posterior surface of the lens, its exact location varying, of course, with the shape and power of the eye. But this point has in truth no more place in the eye system than it has in Drawing VII. It is an imaginary point used for convenience in graphs and calculations. Let us find some appropriate name for it, and not confound it with the OC and NP's.

Gauss in his works stated that for any system of lenses, a single curved surface might be substituted, as has been shown in Drawing VII. And it seems that Gauss located the nodal points of the eye just back of the cornea and called them nodal points and called the C of C of the substituted curved surface the principal point. And it seems that some one who followed Gauss, and did not fully comprehend his ideas and calculations, and who discovered that the image distance and size could be measured from Gauss' Pr. point, mistakenly called it a nodal point.

If the single curved surface may be placed at the nodal points of the eye, instead of the O. C., then we shall have two centers of curvature as far apart as the nodal points. But this is only another hypothesis, as are the nodal planes. The fact is that the axial ray of every secondary pencil is refracted thru the O. C. and not thru the nodal points, as is shown in Drawing VII. And hence the substituted curved surface should be placed at the optical center. Then there is need but for one point, one center of curvature. This may be called the principal point of the eye until a better name is given it.

NOTE: The author hopes that his demonstrations and discussion have been made clear to all those who have taken sufficient interest in these articles to follow them.

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THE CAUSATION OF MYOPIA

Within the past five years optometrists have had considerable success in correcting certain myopic cases by means of base-in prisms. The application of this technic was based on the assumption that, in certain cases the pressure of the internal recti muscles on the globe of the eye was such as to somewhat elongate that eye when near-point work was done. As far as is known no clinical evidence has been produced to support this theory although an impressive number of case reports are on file which seem to substantiate it by results, irrespective of the fact that it has never been proven that undue pressure on the part of the recti muscles will permanently change the contour of the globe of the eye.

It is an accepted fact that heredity plays a part in the development of myopia. Sir Arthur Keith terms myopia a disorder of growth. He attributes this condition to a faulty reaction of the fibroblasts of the sclerotic to the stresses to which they are subject from intra-ocular pressure during the period of growth. If this is true, it obviously explains the part heredity plays in the causation of myopia as it is well known how great a part heredity plays in the matter of growth.

The research work that led Keith to formulate his views on myopia just mentioned seems to fit nicely with those views of modern optometrists who have been correcting or at least checking the pro-

gressive development of myopic cases by means of the base in prism. Keith suggests that increased intra-ocular pressure is the cause and while there is no clinical evidence at hand to prove that the tension of the eye is increased by convergence it is nevertheless probable that in a certain small number of cases the sclerotic is unduly stretched during the early years of life so that accurate focusing can only be obtained by the use of concave lenses.

This theory of Keith's explains, in a measure at least, the successes that have come to optometrists in using the base-in therapies as suggested originally by Peckham and McCullough. As is well known these men advocated crowding on as much base-in prism as could be accepted for near point work in the effort to enable the child to do his near point work with as little effort on the part of convergence as possible.

Improper hygienic conditions and faulty posture also seem to be contributing or secondary factors in causing myopia. Professor George Levinsohn advances certain clinical evidence as gained by experiments on young apes which supports his theory that myopia is caused by venous engorgement which naturally results from prolonged stooping of the head and neck. These factors are also important and should not be ignored. Posture plays an extremely important part in the development of normal health and advice regarding this should always be given the young myope.

Keith's theory has, I believe, placed the base-in therapies for correction of myopia in a better hypothetical position and while these theories are in no way complete the results of the technics do, in a large number of cases, speak for themselves. The entire matter is being studied carefully by a number of conscientious optometrists whose clinical findings have already proven to the world that something can be done for a large number of myopic cases if the treatments are administered reasonably early in the progress of this abnormality.

C. C. K.

INSTRUCTIONS TO BIFOCAL WEARERS

From time to time we are all called upon to give instructions to patients who are about to start wearing bifocals for the first time. Each of us has no doubt developed his own little ceremony in which he counsels his patient regarding the somewhat unusual experience which is about to befall the patient. Obviously it is advantageous to make the matter sufficiently clear to the patient so as to secure the fullest co-operation from the very start. Once a patient has become discouraged we all know how difficult it is to get them to continue wearing a bifocal correction, hence the need for careful and pains taking instructions.

Wm. Heap, an optometrist of England, has some time ago published in the Optician of London the following suggestions which the writer has found to be of value in explaining just what can and cannot be expected from a pair of bifocals as they are being delivered to the user who has never worn them before. Dr. Heap's instructions are as follows:

"(1) The patient is directed to hold the head upright, and perfectly stationary: the reading type is then held below the level of the eyes at reading distance and the patient's eyes directed towards it. The card is then slowly raised. At a certain point the patient will naturally state that the print has become blurred. The reason is stated, and the patient is then directed to rotate the head backwards until the print again becomes clear. The card is again raised, and the above directions repeated. The patient is now acquainted with the limits of the reading segment.

"(2) A card of distance test types is placed on the floor at a distance of four to six yards from the patient, who should be standing, and directed to hold the head upright and stationary with the eyes looking at the card. If the card is blurred, the patient is directed to rotate the head slowly forwards until it becomes clear. The card is then moved nearer the patient, who is asked to keep the head stationary in the last position until the type again becomes blurred. The patient is again directed to rotate the head forwards until clarity of vision is once more attained. This is repeated until the card is at the patient's feet. It should be noted here that the card should be placed in a plane at right angles to the line of vision; also that patients, who are short in stature, may see the type clearly in the first position of four to six yards. This gives the patient a clear idea of the interference of the reading segment with distance vision.

"If the demonstration is concluded with emphasis being laid on the necessity of looking down, with the head bent forward when negotiating steps, the fitter can be almost certain that troubles arising from inability of the patient to become acquainted with the bifocals will be eliminated."

C. C. K.

ANNOTATIONS AND SOCIETY PROCEEDINGS

The American Journal of Optometry is the Official Organ of the American Academy of Optometry, as well as the Organ of the Arkansas, Delaware, Indiana, Iowa, Maine, Maryland, Michigan, Minnesota, Nebraska, North Dakota, Oklahoma, Pennsylvania, South Dakota, Vermont and West Virginia Optometric Associations.

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AUTO DRIVERS' TESTS

Dr. Wm. Mendelsohn writes that Dr. David H. Orkin of the Post Graduate Eye Institute staff has attended the Indiana Automobile Show at LaPorte for the purpose of carrying on the Institute research in its effort to determine the relation between eyes and accidents. The tests were presented under the auspices of Dr. E. Curtis of LaPorte, who in reporting to the Institute, says: "While we were at work in the exhibition building testing eyes, it seemed to be about the most popular attraction there. No other exhibit attracted the crowd as did our booth." As a means of securing publicity for optometry the tests are undoubtedly valuable.

Approximately two hundred persons were given each of the following tests:

(1) Visual acuity.
(2) Cursory fusion and incoordination test.
(3) Depth perception of stereopsis test.
(4) Limits of visual field in horizontal meridian.
(5) Determination of time required for reaction to visible signal.
(6) Determinaton of time required for reaction to sound signal.

Each subject, continues Mendelsohn, was asked if he or she had been involved in any auto accident within a year, while driving and with the car in motion. Ten per cent of the subjects admitted having had accidents, but because it was not possible to substantiate the statements of the subjects with respect to the number of or freedom from accidents experienced, the data gathered cannot be considered as more than valuable indications of the sort of tests that should be

developed and employed, and that will be employed by the Institute Staff on groups of persons whose driving records can be investigated.

The tests of visual acuity consisted simply of the usual reading test, using the Snellen test card. No subject was discovered with worse than 20/50 visual acuity, and for that reason the visual acuity findings are not considered to be significant because it is a matter of simple reasoning and computation that 20/100 acuity (49%) should be sufficient for safe driving at lawful speeds provided other visual factors are normal. It is interesting and significant to observe that of the ten subjects whose visual acuity was 20/50 in either or both eyes, not one had been involved in an accident of any sort within a year.

The cursory fusion and incordination test consisted in placing a red glass before the better eye and having the eyes follow a white object on a dark background over an arc of 120 degrees in the horizontal meridian, with instructions to report any separation of the white and red images; then of producing diplopia by means of placing prism base down before one eye; heterophoria being indicated by the patient's report of the relative position of the two images seen; and finally the brief investigation of the ability to fuse, determined by the promptness with which the red and white images merged when the diplopia producing prism was removed.

Many subjects with slight errors of heterophoria were discovered, but none with heterophoria of significant amount, and none who suffered diplopia in any excursion in spite of the color handicap; and none who failed to fuse instantly when the diplopia producing prism was removed. We of the Institute feel, continues Mendelsohn, that failures to pass this test would be associated with accidents because of observations of selected cases, but in the Indiana group no significant disturbances of ocular coordination were discovered.

The test of depth perception was that included in the government examination of applicants for aviator's license, usually referred to as "the peg test." At a distance of twenty feet, two upright rods, mounted upon movable bases, are moved by means of long cords in the hands of the subject, from extreme separation to their nearest approach to each other; the "pegs" being seen in sharp contrast against a well illuminated background.

The government requires that the pegs be brought within an average of 30 mm. of each other in three trials before passing the applicant for aviation. In the Indiana group we found only sixteen subjects who could not equal this average, and none of the sixteen was involved in accidents. The norm for the Indiana group was 7 and 8 mm. average in three trials, and the departures from normal in the analysis tables accompanying this report are departures from the norm of the group.

The determinations of the time required for reaction to a visible signal were made by means of a device constructed especially for the

purpose, consisting of a concealed falling object which at the start of its fall closes an electric contact, lighting a signal lamp or ringing a bell according to the decision of the operator making the test, and a means for catching the object in its fall actuated by a lever pressed by the subject being tested as soon as the signal is recognized. This device is pictured in the "Popular Mechanics," May issue, page 784. The same device was employed for determination of the time required for reaction to a sound signal. Subjects shown to be relatively "slow" or "fast" in response to either signal are in proportion slow or fast in response to the other. The normal reaction time for response to the visible signal was found to be .32 second, while the normal reaction time to the sound signal was found to be .27 second; the normal person being 15% to 16% quicker in response to sound than in response to the visible signal.

It was further determined that the speed of reaction is increased somewhat by the intensity, or more startling effect of the signal.

While these tests tend to show that sound signals are more effective than visible signals, nothing was discovered to show that slow response to signals is a factor in auto accidents. In fact, the evidence so far indicates that the more deliberate individuals have the fewer accidents.

Nothing was disclosed to indicate that poor vision tends to reduce the promptness of response to light signals, provided the signal is sufficiently conspicuous, and not more than 20/200 vision is required for seeing the signals in present use, or for seeing objects in the road at a sufficient distance ahead to assure safety.

Determinations of the limits of the visual field in the horizontal meridian were made with an ordinary arc perimeter, using a 1 c. m. white target, the subject being permitted to keep both eyes open during the test. Here for the first time were found definite indications of a relation between vision and accidents. The accidents reported by those in the group having approximately normal indirect vision were about fifteen to a hundred persons, while thirty accidents to each hundred persons, (twice as many), were reported by those with less than normal indirect vision, and the percentage of accidents increased as the indirect vision decreases.

Dividing the subjects tested into two groups according to whether or not the individuals admit having had accidents, we find the following:

	Of Those Reporting Accidents	Of Those Reporting No Accidents
Visual acuity below normal	32%	42%
Reaction to visible signal below normal	40%	45%
Reaction to sound signal below normal	32%	40%
Depth perception below normal	74%	74%

Below standard for aviation depth perception.....	0%	15%
Visual fields below 60°.....	16%	11%

Another aspect of the problem is given by dividing the subjects according to the comparison of each individual to the normal in each test.

	Per Cent of Accidents Among Individuals Who Were Normal or Better	Per Cent of Accidents Among Below Normal Individuals
VISUAL acuity	17%	12%
Reaction to visible signal	17%	14%
Reaction to sound signal..	17%	13%
Depth perception	15%	15%
Depth perception	Aviation Standard	Below Aviation Standard
	18%	0%
Visual fields	17%	17%
Visual fields	60° or above	Below 60° in either eye
	11%	16%

Of those with visual fields below 50°, 43% report accidents.

From a study of the above charts three rather obvious conclusions, claims Mendelsohn, must be drawn: (1) Those who are best equipped with keen, direct vision, and a mechanism suited to quick reaction have the most accidents. In other words, those who have reason to place full confidence in their faculties have the greater number of accidents, probably because they are more inclined to be over confident. e

This conclusion is borne out by reports of insurance companies that cars in supposedly first class condition are involved in more accidents than are cars known to be defective with regard to accurate stearing and stopping.

(2) The exception to the above conclusion is the driver (or pedestrian) with markedly reduced indirect vision. It seems that a driver should have normal indirect vision out to 50° from the line of direct vision.

(3) Tests of auto drivers should be looked upon as a means of informing drivers of deficiencies of which they may not be aware rather than to set high standards of innate efficiency to be met. For example, the individual who lacks wide angle vision may be totally unaware of this deficiency until it is pointed out to him.

The Post Graduate Eye Institute plans, according to Mendelsohn, to continue its research along the above lines, employing subjects whose driving records can be investigated. The conclusions drawn from the work already done must be taken as indicative only, not as final. Further observations will be made in these reports as the work progresses.

C. C. K.

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BIFOCALS AND GOLF

The writer had the following unique experience during the past month which he believes to be of sufficient interest to warrant passing it on to the profession. A business executive called at his office for a refraction. This man was hyperopic to the extent of one and one-half diopters and presbyopic to the extent of two diopters. A new pair of bifocals were prescribed for him and in addition to this a pair of single vision sport glasses made up in absorption glass. He was particularly desirous of using this last pair of glasses when he played golf. A few days ago the writer met this patient and upon inquiring how he was getting along was surprised to be told that he had accidentally discovered that if he wore his bifocals while golfing that they improved his game. He claimed that he had forgotten to take his sport glasses with him on a certain afternoon and was therefore obliged to play the round wearing his bifocals. To his surprise he found it entirely possible to use these and claims to have done so purposely on three occasions since. He attributes the success he has had while using his bifocals to the fact that to see the ball at all clearly while wearing them, he was forced to keep his head down to look over the reading area. This he claims was something that he occasionally failed to do without this added stimulus. Perhaps there are other golfers who would appreciate an "ocular-harness" of this character to assist them in overcoming the serious golfing defect of raising the head while driving.

C. C. K.

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OKLAHOMA STATE ASSOCIATION OF OPTOMETRISTS

The annual convention of the Oklahoma State Association of Optometrists was held at the Huckings Hotel, Oklahoma City, on April 26th and 27th. Dr. S. K. Lesser of Fort Worth, Texas, National Study Group Chairman for the Graduate Clinic Foundation served as chief clinician during this convention period.

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MASSACHUSETTS BOARD OF REGISTRATION

The Massachusetts Board of Registration in Optometry will hold its next examination on June 23, 24, 25 and 26, 1931, at the State House, Boston, Massachusetts. The Practical examination will include among other things a demonstration of ability to map the central, para-central and peripheral fields. The instruments to be used will include the Ferre-Rand or A. O. Co. Perimeter and Stereo Campimeter.

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IOWA STATE ASSOCIATION

The annual convention of the Iowa State Association of Optometrists was held at the Hotel Savery in Des Moines on April 26, 27 and 28.

SAN FRANCISCO OPTOMETRIC ASSOCIATION

Dr. S. E. Kessel, Associate Professor of the Biological Sciences at the University of San Francisco, spoke before the San Francisco Association of Optometrists on Tuesday evening, April 14th. His subject was, "Insect Carriers of Ocular Disease."

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CHI CHAPTER BETA SIGMA KAPPA

Dr. W. Jerome Heather of the Northern Illinois College of Optometry, spoke on "Fraternalism—its Optometric Significance," at the former meeting of the Chi Chapter in Chicago on Friday, March 20th. At the close of his address, Dr. Heather was presented with a certificate confering upon him the Honorary Doctor of Optometric Science Degree as awarded by the scientific section of the Beta Sigma Kappa.

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AMERICAN OPTOMETRIC ASSOCIATION

The thirty-fourth annual convention of the American Optometric Association will be held at the Gunter Hotel in San Antonio, Texas, the week of June 21st. Four special trains are being provided for the delegates at reduced rates and a large attendance is expected.

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CONNECTICUT OPTOMETRIC SOCIETY

Dr. A. M. Skeffington of the Graduate Clinic Foundation, conducted clinics in Hartford and New Haven the week of April 15th. Forty optometrists were in attendance during these two clinic periods.

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KIEKENAPP RECORD CARD

Dr. Ernest H. Kiekenapp of Faribault, Minnesota, National Secretary of the American Optometric Association, announces that he has incorporated the Skeffington eighteen point diagnostic outline in his new 5x8 record card, which takes the place of the old record card which has enjoyed such a wide popularity with many optometrists. These cards are procurable from the publishers, **i.e.**, the N. P. Benson Optical Company, Minneapolis, or from local jobbers.

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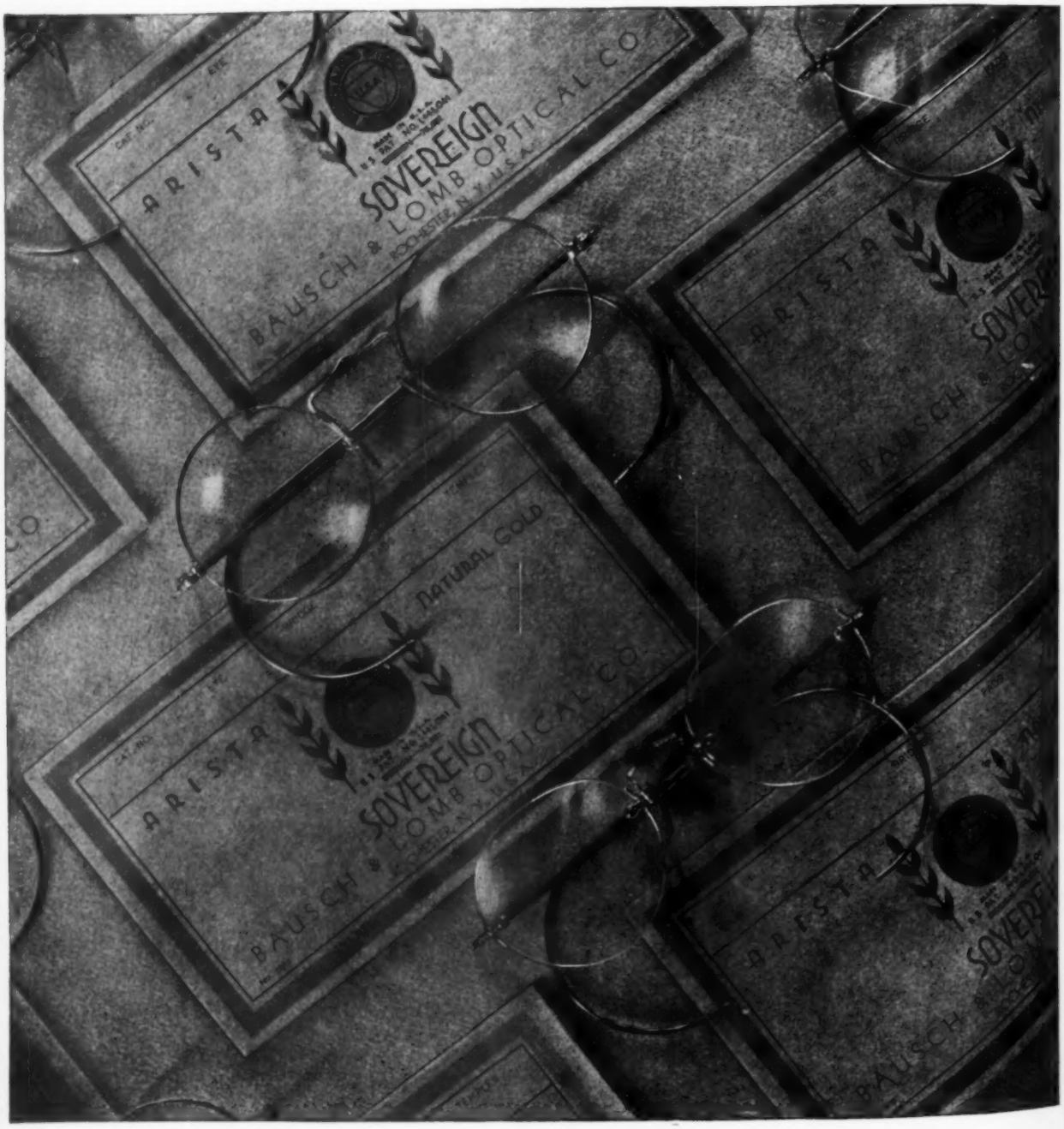
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